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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2019-0152; Special Conditions No. 25-744A-SC]

Special Conditions: Greenpoint Technologies, Inc., Boeing Model 787-8 Airplane; Dynamic Test Requirements for Single-Occupant, Side-Facing Seats with Airbag Devices in Shoulder Belts

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions; request for comments.

SUMMARY: These amended special conditions are issued for the Boeing Model 787-8 airplane. This amendment removes reference to leg-flail airbags and adds reference to leg-flail devices installed on side-facing seats. This airplane, as modified by Greenpoint Technologies, Inc. (Greenpoint), will have a novel or unusual design feature when compared to the state of technology envisioned in the airworthiness standards for transport category airplanes. This design feature is single-occupant, side-facing seats with airbag devices in shoulder belts, and a floor-level, leg-flail-prevention device to limit the axial rotation of the upper leg. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

DATES: This action is effective on Greenpoint Technologies, Inc. on [INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]. Send comments on or before [INSERT DATE 45 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Send comments identified by Docket No. FAA-2019-0152 using any of the following methods:

- *Federal eRegulations Portal:* Go to <http://www.regulations.gov/> and follow the online instructions for sending your comments electronically.
- *Mail:* Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE., Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- *Hand Delivery or Courier:* Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

Privacy: The FAA will post all comments it receives, without change, to <http://www.regulations.gov/>, including any personal information the commenter provides. Using the search function of the docket Web site, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the *Federal Register* published on April 11, 2000 (65 FR 19477-19478).

Docket: Background documents or comments received may be read at <http://www.regulations.gov/> at any time. Follow the online instructions for accessing the docket or go to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Shannon Lennon, Airframe & Cabin Safety Section, AIR-675, Transport Standards Branch, Policy and Innovation Division, Aircraft Certification Service, Federal Aviation Administration, 2200 South 216th Street, Des Moines, Washington 98198; telephone and fax 206-231-3209; e-mail shannon.lennon@faa.gov.

SUPPLEMENTARY INFORMATION: The FAA has determined that notice of, and opportunity for prior public comment on, these special conditions is impracticable because the substance of these special conditions has been published in the *Federal Register* for public comment in several prior instances with no substantive comments received. The FAA therefore finds it unnecessary to delay the effective date and finds that good cause exists for making these special conditions effective upon publication in the *Federal Register*.

Comments Invited

We invite interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data.

We will consider all comments we receive by the closing date for comments. We may change these special conditions based on the comments we receive.

Background

On June 15, 2017, Greenpoint applied for a supplemental type certificate for single-occupant, side-facing seats with airbag devices in shoulder belts, and a floor-level, leg-flail-prevention device to limit the axial rotation of the upper leg, installed in Boeing Model 787-8 airplanes. On May 2, 2019, Special Conditions No. 25-744-SC was published in the Federal Register (85 FR 18701). At the request of the applicant, this amended special conditions removes reference to leg-flail airbags and adds reference to leg-flail devices installed on side-facing seats.

The Boeing Model 787-8 airplane, which is a derivative of the Boeing Model 787 currently approved under Type Certificate No. T00021SE, is a twin-engine, transport-category airplane with a maximum takeoff weight of 502,500 pounds. The airplanes, as modified by Greenpoint, will have a business-jet interior with a maximum seating capacity of 41.

Type Certification Basis

Under the provisions of title 14, Code of Federal Regulations (14 CFR) 21.101, Greenpoint must show that the Boeing Model 787-8 airplane, as changed, continues to meet the applicable provisions of the regulations listed in Type Certificate No. T00021SE, or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Boeing Model 787-8 airplane because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the applicant apply for a supplemental type certificate to modify any other model included on the same type certificate to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Boeing Model 787-8 airplane must comply with the fuel-vent and exhaust-emission requirements of 14 CFR part 34, and the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

Novel or Unusual Design Features

The Boeing Model 787-8 airplane, as modified by Greenpoint, will incorporate the following novel or unusual design features:

Single-occupant, side-facing seats with airbag devices in shoulder belts and a floor-level, leg-flail-prevention device to limit the axial rotation of the upper leg.

Discussion

Amendment 25-64, dated June 16, 1988, revised the emergency-landing conditions that must be considered in the design of the airplane. It revised the static-load conditions in § 25.561 and added a new § 25.562, requiring dynamic testing for all seats approved for occupancy during takeoff and landing. The intent was to provide an improved level of safety for occupants on transport-category airplanes. Because most seating on transport-category airplanes is forward-facing, the pass/fail criteria developed in Amendment 25-64 focused primarily on forward-facing seats. Therefore, the testing specified in the rule did not provide a complete measure of occupant injury in seats that are not forward-facing, although § 25.785 does require occupants of all seats that are occupied during taxi, takeoff, and landing not suffer serious injury as a result of the inertia forces specified in §§ 25.561 and 25.562.

For some time the FAA granted exemptions for the multiple-place side-facing-seat installations because the existing test methods and acceptance criteria did not produce a level of safety equivalent to the level of safety provided for forward- and aft-facing seats. These exemptions were subject to many conditions that reflected the injury-evaluation criteria and mitigation strategies available at the time of the exemption issuance. The FAA also issued special conditions to address single-place side-facing seats because we believed that those conditions provided the same level of safety as for forward- and aft-facing seats.

Continuing concerns regarding the safety of side-facing seats prompted the FAA to conduct research to develop an acceptable method of compliance with §§ 25.562 and 25.785(b) for side-facing seat installations. That research has identified injury considerations and evaluation criteria in addition to those previously used to approve side-facing seats (see published report DOT/FAA/AR-09/41, July 2011). One particular concern that was identified during the FAA's research program, but not addressed in the previous special conditions, was the significant leg injuries that can occur to occupants of both single- and multiple-place side-facing seats. Because this type of injury does not occur on forward- and aft-facing seats, the FAA determined that, to achieve the level of safety envisioned in Amendment 25-64, additional requirements would be needed as compared to previously issued special conditions. Nonetheless, the research has now allowed the development of a single set of special conditions applicable to all fully side-facing seats.

On November 5, 2012, the FAA released PS-ANM-25-03-R1, "Technical Criteria for Approving Side-Facing Seats," to update existing FAA certification policy on §§ 25.562 and 25.785(a) at Amendment 25-64 for single- and multiple-place side-facing seats. This policy addresses both the technical criteria for approving side-facing seats and the implementation of those criteria. The FAA methodology detailed in PS-ANM-25-03-R1 has been used to establish a new set of proposed special conditions.

These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Applicability

As discussed above, these special conditions are applicable to Boeing Model 787-8 airplanes modified by Greenpoint. Should Greenpoint apply at a later date for a supplemental type certificate to modify any other model included on Type Certificate No. T00021SE to incorporate the same novel or unusual design feature, these special conditions would apply to that model as well.

Conclusion

This action affects only a certain novel or unusual design feature on one model of airplanes. It is not a rule of general applicability and affects only the applicant who applied to the FAA for approval of these features on the airplane.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

Authority Citation

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(f), 106(g), 40113, 44701, 44702, 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Boeing Model 787-8 airplanes modified by Greenpoint.

In addition to the airworthiness standards in §§ 25.562 and 25.785, special conditions 1 and 2 apply to all side-facing seat installations, and special conditions 3 through 16 apply to side-facing seats equipped with an airbag system in the shoulder-belt system.

1. Additional requirements applicable to tests or rational analysis conducted to show compliance with §§ 25.562 and 25.785 for side-facing seats:
 - a. The longitudinal test(s) conducted in accordance with § 25.562(b)(2) to show compliance with the seat-strength requirements of § 25.562(c)(7) and (8), and these special conditions must have an ES-2re Anthropomorphic Test Dummy (ATD) (49 CFR part 572, subpart U) or equivalent, or a Hybrid-II ATD (49 CFR part 572, subpart B, as specified in § 25.562) or equivalent, occupying each seat position and including all items contactable by the occupant (e.g., armrest, interior wall, or furnishing) if those items are necessary to restrain the occupant. If included, the floor representation and contactable items must be located such that their relative position, with respect to the center of the nearest seat place, is the same at the start of the test as before floor misalignment is applied. For example, if floor misalignment rotates the centerline of the seat place nearest the contactable item 8 degrees clockwise about the airplane x-axis, then the item and floor representations must be rotated by 8 degrees clockwise also to maintain the same relative position to the seat place. Each ATD's relative position to the seat after application of floor misalignment must be the same as before misalignment is applied. To ensure proper loading of the seat by the occupants, the ATD pelvis must remain supported by the seat pan, and the restraint system must remain on the pelvis and shoulder of the ATD until rebound begins. No injury-criteria evaluation is necessary for tests conducted only to assess seat-strength requirements.

- b. The longitudinal test(s) conducted in accordance with § 25.562(b)(2), to show compliance with the injury assessments required by § 25.562(c) and these special conditions, may be conducted separately from the test(s) to show structural integrity. In this case, structural-assessment tests must be conducted as specified in paragraph 1a, above, and the injury-assessment test must be conducted without yaw or floor misalignment. Injury assessments may be accomplished by testing with ES-2re ATD (49 CFR part 572, subpart U) or equivalent at all places. Alternatively, these assessments may be accomplished by multiple tests that use an ES-2re at the seat place being evaluated, and a Hybrid-II ATD (49 CFR part 572, subpart B, as specified in § 25.562) or equivalent used in all seat places forward of the one being assessed, to evaluate occupant interaction. In this case, seat places aft of the one being assessed may be unoccupied. If a seat installation includes adjacent items that are contactable by the occupant, the injury potential of that contact must be assessed. To make this assessment, tests may be conducted that include the actual item, located and attached in a representative fashion. Alternatively, the injury potential may be assessed by a combination of tests with items having the same geometry as the actual item, but having stiffness characteristics that would create the worst case for injury (injuries due to both contact with the item and lack of support from the item).
- c. If a seat is installed aft of structure (e.g., an interior wall or furnishing) that does not have a homogeneous surface contactable by the occupant, additional analysis and/or test(s) may be required to demonstrate that the injury criteria are met for the area which an occupant could contact. For example, different yaw angles

could result in different injury considerations and may require additional analysis or separate test(s) to evaluate.

- d. To accommodate a range of occupant heights (5th percentile female to 95th percentile male), the surface of items contactable by the occupant must be homogenous 7.3 inches (185 mm) above and 7.9 inches (200 mm) below the point (center of area) that is contacted by the 50th percentile male size ATD's head during the longitudinal test(s) conducted in accordance with paragraphs a, b, and c, above. Otherwise, additional head-injury criteria (HIC) assessment tests may be necessary. Any surface (inflatable or otherwise) that provides support for the occupant of any seat place must provide that support in a consistent manner regardless of occupant stature. For example, if a shoulder-belt airbag system is used to mitigate injury risk, then it must be demonstrated by inspection to bear against the range of occupants in a similar manner before and after inflation. Likewise, the means of limiting lower-leg flail must be demonstrated by inspection to provide protection for the range of occupants in a similar manner.
- e. For longitudinal test(s) conducted in accordance with § 25.562(b)(2) and these special conditions, the ATDs must be positioned, clothed, and have lateral instrumentation configured as follows:
 - i. ATD positioning - Lower the ATD vertically into the seat while simultaneously:
 - 1. Aligning the midsagittal plane (a vertical plane through the midline of the body; dividing the body into right and left halves) with approximately the middle of the seat place.

2. Applying a horizontal x-axis direction (in the ATD coordinate system) force of about 20 lb (89 N) to the bottom of the feet of the ES-2re Hybrid-II, to compress the seat back cushion.
 3. Keeping the lower and upper legs nearly horizontal by supporting at the bottom of the feet.
- ii. Once all lifting devices have been removed from the ATD:
1. Rock it slightly to settle it in the seat.
 2. Bend the knees of the ATD.
 3. Separate the knees by about 4 inches (100 mm).
 4. Set the ES-2re's head at approximately the midpoint of the available range of z-axis rotation (to align the head and torso midsagittal planes).
 5. Position the ES-2re's arms at the joint's mechanical detent that puts them at approximately a 40 degree angle with respect to the torso. Position the Hybrid-II ATD hands on top of its upper legs.
 6. Position the feet such that the centerlines of the lower legs are approximately parallel to a lateral vertical plane (in the airplane coordinate system).
- iii. ATD clothing: Clothe each ATD in form-fitting, mid-calf-length (minimum) pants and shoes (size 11E) weighing about 2.5 lb (1.1 kg) total. The color of the clothing should be in contrast to the color of the restraint system. The ES-2re jacket is sufficient for torso clothing, although a form-fitting shirt may be used in addition if desired.

- iv. ES-2re ATD lateral instrumentation: The rib-module linear slides are directional, i.e., deflection occurs in either a positive or negative ATD y-axis direction. The modules must be installed such that the moving end of the rib module is toward the front of the airplane. The three abdominal-force sensors must be installed such that they are on the side of the ATD toward the front of the airplane.
- f. The combined horizontal/vertical test, required by § 25.562(b)(1) and these special conditions, must be conducted with a Hybrid II ATD (49 CFR part 572, subpart B, as specified in § 25.562), or equivalent, occupying each seat position.
- g. Restraint systems:
 - i. If inflatable restraint systems are used, they must be active during all dynamic tests conducted to show compliance with § 25.562.
 - ii. The design and installation of seat-belt buckles must prevent unbuckling due to applied inertial forces or impact of the hands/arms of the occupant during an emergency landing.
- 2. Additional performance measures applicable to tests and rational analysis conducted to show compliance with §§ 25.562 and 25.785 for side-facing seats:
 - a. Body-to-body contact: Contact between the head, pelvis, torso, or shoulder area of one ATD with the adjacent-seated ATD's head, pelvis, torso, or shoulder area is not allowed. Contact during rebound is allowed.
 - b. Thoracic: The deflection of any of the ES-2re ATD upper, middle, and lower ribs must not exceed 1.73 inches (44 mm). Data must be processed as defined in Federal Motor Vehicle Safety Standards (FMVSS) 571.214.

- c. Abdominal: The sum of the measured ES-2re ATD front, middle, and rear abdominal forces must not exceed 562 lbs (2,500 N). Data must be processed as defined in FMVSS 571.214.
- d. Pelvic: The pubic symphysis force measured by the ES-2re ATD must not exceed 1,350 lbs (6,000 N). Data must be processed as defined in FMVSS 571.214.
- e. Leg: Axial rotation of the upper-leg (femur) must be limited to 35 degrees in either direction from the nominal seated position. The leg-flail-prevention mechanism must:
 - i. Be shown to function as intended in consideration of post-structural deformation of the seat assembly.
 - ii. Retract such that it does not impede rapid egress of occupants.
- f. Neck: As measured by the ES-2re ATD and filtered at CFC 600 as defined in SAE J211:
 - i. The upper-neck tension force at the occipital condyle (O.C.) location must be less than 405 lbs (1,800 N).
 - ii. The upper-neck compression force at the O.C. location must be less than 405 lbs (1,800 N).
 - iii. The upper-neck bending torque about the ATD x-axis at the O.C. location must be less than 1,018 in-lbs (115 Nm).
 - iv. The upper-neck resultant shear force at the O.C. location must be less than 186 lbs (825 N).

- g. Occupant (ES-2re ATD) retention: The pelvic restraint must remain on the ES-2re ATD's pelvis during the impact and rebound phases of the test. The upper-torso restraint straps (if present) must remain on the ATD's shoulder during the impact.
 - h. Occupant (ES-2re ATD) support:
 - i. Pelvis excursion: The load-bearing portion of the bottom of the ATD pelvis must not translate beyond the edges of its seat's bottom seat-cushion supporting structure.
 - ii. Upper-torso support: The lateral flexion of the ATD torso must not exceed 40 degrees from the normal upright position during the impact.
- 3. For seats with a shoulder-belt airbag system, the shoulder-belt airbag system must deploy and provide protection under crash conditions where it is necessary to prevent serious injury. The means of protection must take into consideration a range of stature from a 2-year-old child to a 95th percentile male. The airbag systems in the shoulder belts must provide a consistent approach to energy absorption throughout that range of occupants. When the seat system includes an airbag system, that system must be included in each of the certification tests as it would be installed in the airplane. In addition, the following situations must be considered:
 - a. The seat occupant is holding an infant.
 - b. The seat occupant is a pregnant woman.
- 4. The airbag system in the shoulder belt must provide adequate protection for each occupant regardless of the number of occupants of the seat assembly, considering that unoccupied seats may have an active airbag system in the shoulder belt.

5. The design must prevent the airbag system in the shoulder belt from being either incorrectly buckled or incorrectly installed, such that the airbag system in the shoulder belt would not properly deploy. Alternatively, it must be shown that such deployment is not hazardous to the occupant, and will provide the required injury protection.
6. It must be shown that the shoulder-belt airbag system is not susceptible to inadvertent deployment as a result of wear and tear, or inertial loads resulting from in-flight or ground maneuvers (including gusts and hard landings), and other operating and environmental conditions (vibrations, moisture, etc.) likely to occur in service.
7. Deployment of the shoulder-belt airbag system must not introduce injury mechanisms to the seated occupant, or result in injuries that could impede rapid egress. This assessment should include an occupant whose belt is loosely fastened.
8. It must be shown that inadvertent deployment of the shoulder-belt airbag system, during the most critical part of the flight, will either meet the requirement of § 25.1309(b) or not cause a hazard to the airplane or its occupants. This also includes preventing inadvertent airbag deployment from a static discharge.
9. It must be shown that the airbag system in the shoulder belt will not impede rapid egress of occupants 10 seconds after airbag deployment.
10. The shoulder-belt airbag system must be protected from lightning and high-intensity radiated fields (HIRF). The threats to the airplane specified in existing regulations regarding lightning, § 25.1316, and HIRF, § 25.1317, are incorporated by reference for the purpose of measuring lightning and HIRF protection.
11. The shoulder-belt airbag system must function properly after loss of normal airplane electrical power, and after a transverse separation of the fuselage at the most critical

location. A separation at the location of the airbag system in the shoulder belt does not have to be considered.

12. It must be shown that the shoulder-belt airbag system will not release hazardous quantities of gas, sharp injurious metal fragments, or particulate matter into the cabin.
13. The shoulder-beltairbag system installation must be protected from the effects of fire such that no hazard to occupants will result.
14. A means must be available for a crewmember to verify the integrity of the shoulder-beltairbag system activation system prior to each flight, or it must be demonstrated to reliably operate between inspection intervals. The FAA considers that the loss of the airbag-system deployment function alone (i.e., independent of the conditional event that requires the airbag-system deployment) is a major-failure condition.
15. The inflatable material may not have an average burn rate of greater than 2.5 inches/minute when tested using the horizontal flammability test defined in part 25, appendix F, part I, paragraph (b)(5).
16. The shoulder-belt airbag system, once deployed, must not adversely affect the emergency-lighting system (i.e., block floor proximity lights to the extent that the lights no longer meet their intended function).

Issued in Des Moines, Washington, on May 30, 2019.

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